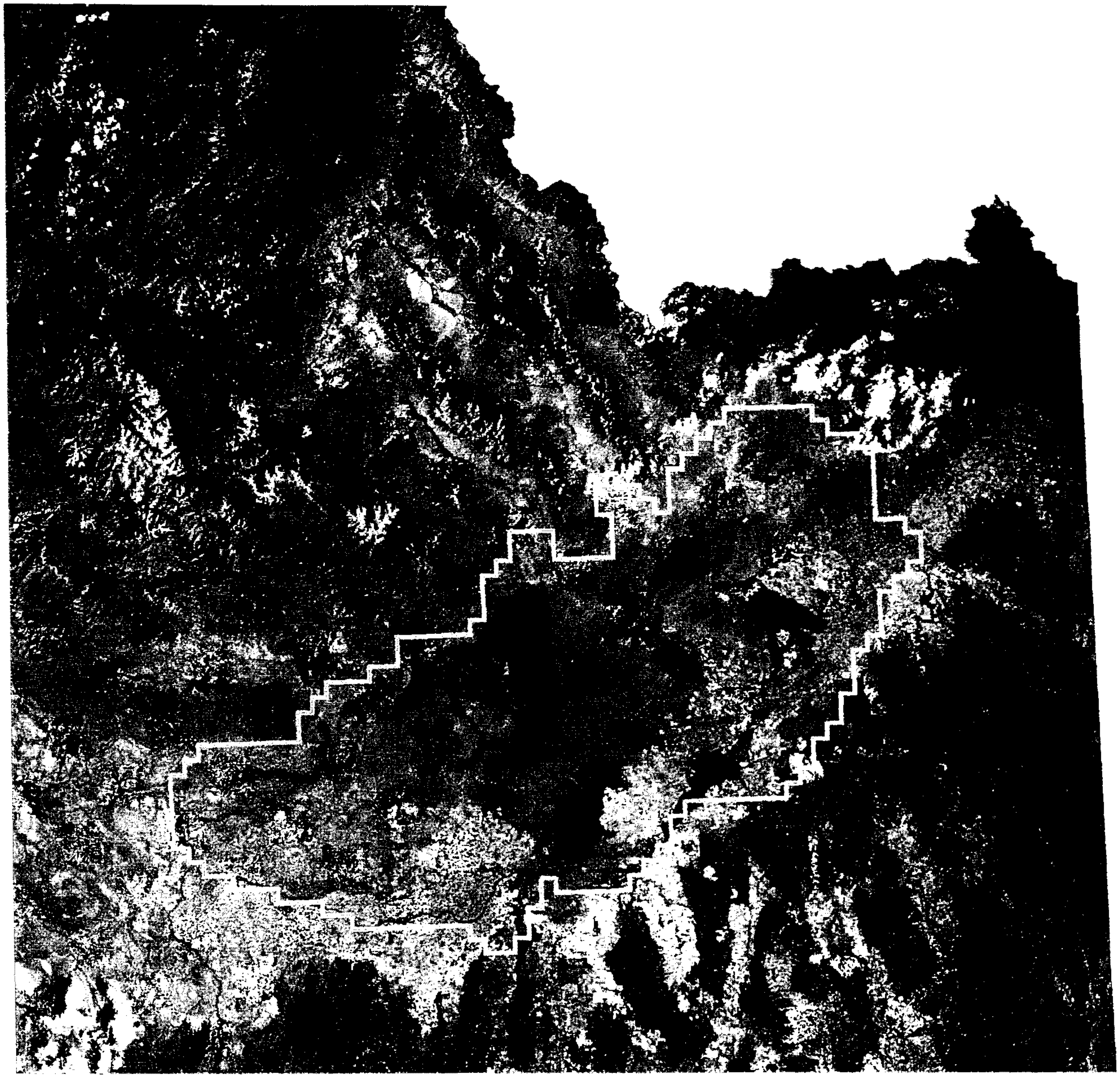
UPPER SNAKE RIVER BASIN STUDY



Idaho Department of Water Resources
Boise, Idaho

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FOREWORD

by the Idaho Technical Committee on Hydrology

The "Upper Snake River Basin Study" is a hydrologic study performed by the Idaho Department of Water Resources (IDWR) as a result of a settlement agreement between IDWR and complainants concerned with diversions from junior ground water and surface water users in the Upper Snake River Basin. A technical committee prepared the study plan that was submitted to the State of Idaho for funding. The state legislature and other entities subsequently funded the study plan with minor modifications and directed IDWR to perform the study. The Idaho Technical Committee on Hydrology (ITCH) was selected to provide technical advice and review.

IDWR conducted the study and the University of Idaho assisted with ground water modeling and managed recharge analysis. ITCH provided technical advice and review based on the study plan, detailed study tasks and conclusions. IDWR considered the technical comments and advice from ITCH and incorporated recommendations in their procedures.

The study report addresses the objectives that were developed from the list of study elements prepared by the settlement technical advisory group. Some of the study elements involved planning scenarios for other agencies; these objectives and results based on these elements are not included in this report.

Seven refined study objectives were addressed. However, to the extent specific detailed mitigation plans were expected to result from objective seven, which was "prepare possible plans for mitigation of depletion of natural flow supplies in Water District 1 resulting from ground water pumping on the ESPA", sufficient resources were not provided to fully accomplish this task. The epilogue by Karl J. Dreher, Director of the IDWR, addresses concepts for mitigation and provides an overall plan for approaching mitigation in the near term.

The results of this study are based on a regional hydrologic model and hydrologic data sets that approximate recent average conditions for the base simulation. Water supply and water use changes from the base condition were simulated for various scenarios. Because average conditions were assumed for all simulations, the modeled absolute water surface elevations and spring discharges may not necessarily portray current or future observed elevations and discharges. However, the differences in simulated responses illustrate the relative magnitude of regional impacts.

ITCH recognizes that collection and analysis of additional hydrologic and land use data for studies dealing with regional impacts would enhance confidence in results. Although the economics and time requirements of this study did not allow collection of additional data, study results are directly commensurate with the analysis and study procedures applied given the resources provided. Refined regional and local studies will require an extended analysis of additional hydrologic and land use data in relation to the geohydrologic framework of the eastern Snake Plain aquifer system.

This study identified significant impacts on aquifer levels and spring flows resulting from land use changes. The magnitude of these impacts is sufficient to require the State to develop and implement mitigation policies in the context of conjunctive surface and ground water management.

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INTRODUCTION

BACKGROUND

In July 1992, the North Side Canal Company (NSCC) and the Twin Falls Canal Company (TFCC) filed a "Complaint for Preliminary and Permanent Injunction" against the Idaho Department of Water Resources (IDWR). The complaint sought to enjoin IDWR from permitting additional consumptive diversion from ground and surface waters in the "non-trust area", the area defined by IDWR as tributary to the Snake River above Milner Dam. The purpose of this action was to stop further impacts on the natural flow available to the two canal companies. In January 1993, negotiations between the canal companies and IDWR led to a Settlement Agreement with IDWR. The agreement provided for modification and extension of an existing moratorium on permitting new water rights and a study of the interrelationshipsbetween the Snake River and the Eastern Snake Plain Aquifer (ESPA).

The agreement called for creation of a temporary technical advisory committee to prepare a detailed plan of study which would be submitted to state, federal and local entities for funding. The technical advisory committee consisted of representatives from the University of Idaho (UI), United States Bureau of Reclamation (USBR), IDWR, the Idaho Legislature, and private consultants. This team completed a list of study elements in February 1993 for submission to the 1993 Legislature. The study elements were approved by the legislature, with the exception of a conservation element, and partial funding was appropriated for a three year study to be directed by IDWR. Additional funding was provided by NSCC, TFCC, Idaho Power Company, and USBR.

The study elements developed by the technical committee are contained in Appendix A. Study elements were identified to directly respond to the Settlement Agreement concerns over development in the non-trust area above Milner Dam and its effect on natural flow users in the Upper Snake River water regulation district, Water District 1. These include defining the impacts of existing and possible future changes in ground water withdrawals and recharge.

In view of the fact that the Idaho Water Resource Board (IWRB) had previously scheduled a planning study over the ESPA, the technical committee decided to broaden this study to cover the entire aquifer, including that part of the trust area which is tributary to the Milner Dam to King Hill reach of the Snake River. Supporting this action was the fact that the Settlement Agreement acknowledged the efficiencies of expanding the study to include the entire aquifer. The committee recognized that issues parallel to the main ESPA also occur in aquifers of tributary basins. Although studies of these areas were considered beyond the scope of this study, a study element was added to prepare *plans* of study of how these areas would be addressed.

Prior to disbanding, the technical committee considered the need for peer review throughout the three year study to assure widespread acceptance and accuracy of the study results. The Idaho Technical Committee on Hydrology (ITCH) was asked to provide review and oversight as the study progressed. The ITCH group consists of representatives from several public and private agencies which have interests in hydrologic matters in Idaho. Membership is informal and flexible depending on the issues being addressed. Meetings are held periodically throughout the year in response to need. The study was reviewed by ITCH throughout its course.

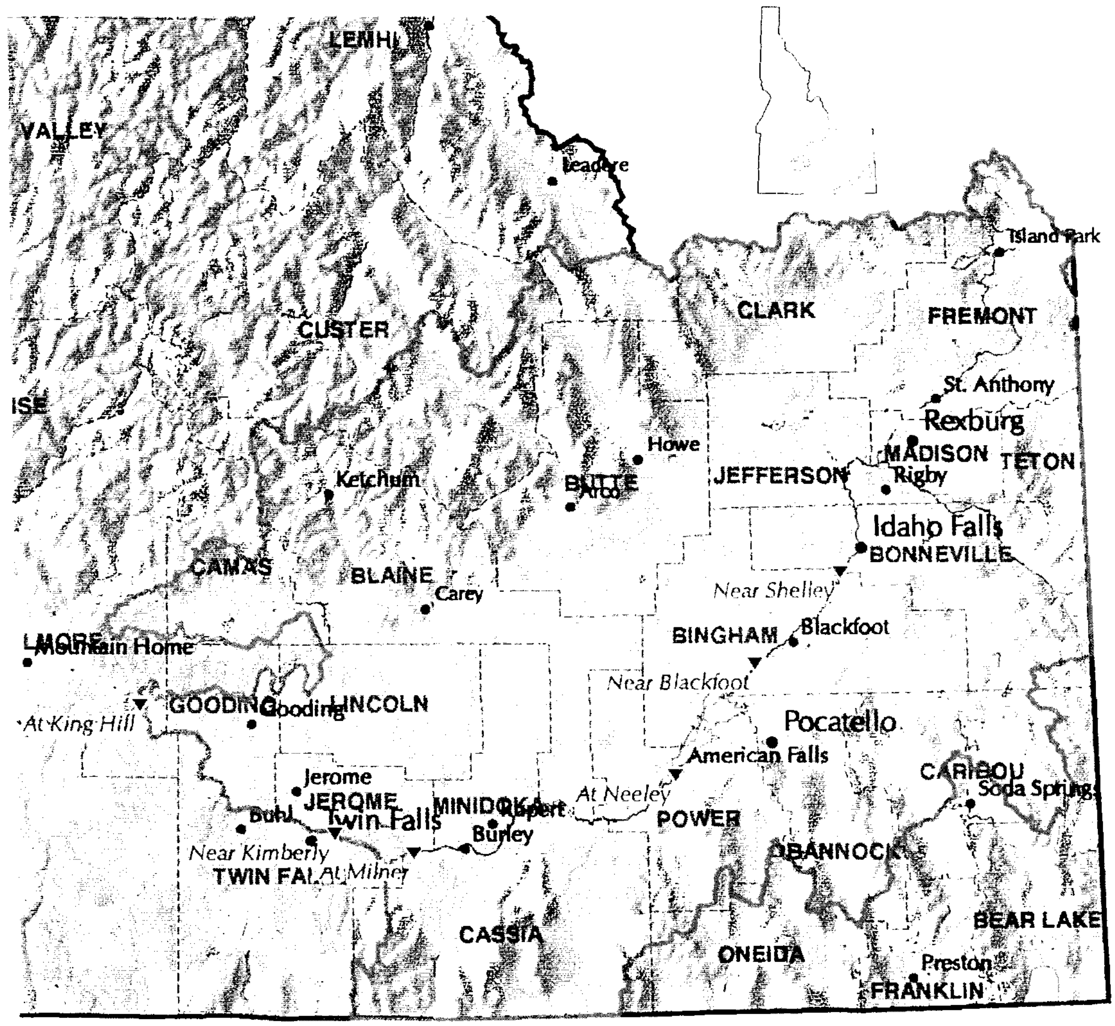
STUDY AREA

The general study area, shown in Figure 1, includes the main Snake River Basin above the King Hill gaging station. Primary emphasis is on the ESPA area tributary to the Snake River above Milner Dam (at the Milner gaging station). However, aquifer simulations include changes in uses over the entire ESPA and changes in spring outflows between Milner Dam and King Hill. Plans of study were prepared for areas tributary to the main ESPA, but no studies were completed. A detailed description of the study area is given by Garabedian, (1992). Key Snake River gaging stations referred to in this report are also shown in Figure 1.

PROBLEM

Spring discharges from the ESPA occur primarily in the Shelley to Neeley and Milner to King Hill reaches of the Snake River. Spring discharge in the Blackfoot to Neeley reach (within the Shelley to Neeley reach) increased from less than 2000 cfs in the early 1900's to a rather constant 2500 cfs from 1912 to 1980; spring discharges from Milner to King Hill increased from about 4200 cfs in the early 1900's to more than 6500 cfs in the mid-1950's, after which declines began to occur (Kjelstrom, 1986). No data are available to estimate spring discharges prior to 1900. Surface water irrigation began in the late 1800's and likely had already affected the spring discharges by 1900. Causes for recent declines in the Milner to King Hill spring discharges include the rapid growth of ground water irrigation since 1950, cessation of winter diversions by most of the Snake River canals in about 1960, and large reductions in summer diversions which began in the late 1970's. Early 1990's data indicate Milner to King Hill spring discharges in the range of 5200 cfs. Spring discharges from Shelley to Neeley are a part of the natural flow allocated by Water District 1 according to water right priorities to surface water users. Declines in spring discharges from Milner to King Hill have affected users in this reach, primarily aquaculture interests which depend on high quality spring flows for fish production. Concurrent water table declines over much of the ESPA have resulted in increased pumping head for ground water users.

Figure 1. Upper Snake River Basin Study Area



▼ Gaging station

OBJECTIVES

Study objectives are a composite of objectives derived from the Settlement Agreement, technical advisory committee study elements, IWRB planning needs, and ITCH recommendations. The decision to broaden the study to respond to multiple questions led IDWR to identify the following objectives:

> Estimate the effects of ground water withdrawals from the ESPA on river flows in Water District 1 and in the Thousand Springs area. Show corresponding water table elevation changes throughout the aquifer.
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> Prepare and demonstrate a method of accounting for the effect of ground water withdrawals from the ESPA in the allocation of natural flow and use of stored water in Water District 1.
>
> Estimate the effects of reduced diversions by surface water irrigators since the mid 1970's on ground water discharges to surface sources within Water District 1 and in the Thousand Springs area and show corresponding water table elevation changes throughout the aquifer.
>
> Estimate the effects of further reductions in surface diversions on ground water discharges to surface sources within Water District 1 and in the Thousand Springs area. Show corresponding water table elevation changes throughout the aquifer.
>
> Prepare study plans including time and cost estimates for evaluating the hydrologic effects of ground water withdrawals in each major tributary basin of the ESPA.
>
> Prepare hydrologic evaluations of potential managed ground water recharge programs to the ESPA as possible mitigation to declining spring flows and water tables.
>
> Prepare possible plans for mitigation of depletion of natural flow supplies in Water District 1 resulting from ground water pumping on the ESPA.

OVERVIEW

Aquifer response to various conditions were evaluated using the IDWR/UI ESPA ground water flow model. The model was calibrated to 1980 conditions; recharge and discharge for current conditions (1982 to 1992) were then added to the model. This is discussed in the section "IDWR/UI Ground Water Flow Model". A "base study" was then run to represent conditions if recharge and withdrawal were to remain at current levels for the indefinite future. The ESPA is currently not at equilibrium, a condition when inflows and outflows balance. If inputs and withdrawals were to remain at current levels for an indefinite period, the spring outflows would adjust until they, combined with the fixed withdrawals, would come into balance with the recharge. Water table levels throughout the aquifer would adjust to a constant elevation. The base study provides a point of reference for measuring the effects of a change. It also serves as an indicator of what will happen to the aquifer and outflows if no further change occurs. Development of the base study is described in the section "ESPA Base Study".

Each "what if" simulation represents a condition altered from the base conditions. Computed differences in flow to the river between the simulation and the base study are used to estimate the effect of the withdrawals on river gains. The ground water model calculates water table elevations and ground water flow through the aquifer. Each simulation is run for many years and this output information is available at the end of any chosen period. Water table elevations for each time period are computed on a 5 km (3.1 mi) grid. Outflows are computed on the margins of this grid in discharge areas using the same grid.

To evaluate the effects of estimated historical ground water withdrawals on spring flows to the river, withdrawals were removed and a model simulation was run to a new equilibrium condition. Simulation of this "no ground water" withdrawal condition (see "No Ground Water" Study section) provides an estimate of the effects of irrigation wells on the river. This data was used to adjust the natural flow supply of the Snake River which is allocated to the various canals in the Water District 1 accounting. A description of a potential adjustment process and the resulting impact on surface users is contained in the section "Impacts of ESPA Ground Water Irrigation on Water District 1 Surface Water Users".

Irrigation withdrawals and recharge are not static over the ESPA. The decline in recharge from surface diversions in the past 25 years (1967 to 1992) was evaluated with a model simulation. In this simulation the change from the base study was the difference between average surface diversions from 1965 to 1976 compared to average surface diversions from 1982 to 1992. Improvements in the efficiency of surface water irrigation systems are likely to continue, resulting in further declines in recharge. The section entitled "Effects of Surface Water Efficiency Improvements" discusses past and potential future changes in irrigation efficiencies and aquifer response using model simulations.

Study plans for the major basins tributary to the ESPA were developed and prioritized as low, medium or high based on the amount of current and historic ground water activity in the basin. This information is summarized in the section entitled "ESPA Tributary Basin Plans" and includes cost and labor estimates for each basin plan.

Over the past several years, there have been many proposals for reversing declining spring flows and water tables over the ESPA, as well as storing surplus runoff from the Snake River by diverting surface runoff to recharge the aquifer. The University of Idaho was retained to identify potential recharge locations using existing canals overlying the ESPA. Water supply models were used to estimate availability of surplus Snake River flows. Flows were matched with the diversion capability of existing canals to calculate potential recharge volumes. Model runs were made (see "ESPA Managed Recharge" section) to assess the impact these recharge volumes would have on spring outflows from the ESPA and corresponding water table changes.

It is important to note that *the model simulations in this study do not illustrate effects on a local level.* Because the initial set up, or calibration, of the model is dependent on data more widely spaced than the 5 km grid, it is not correct to claim accuracy of model computed elevations and outflows at each grid point. For example, there are 11 grid cells between Neeley and Minidoka, a reach of the river where gains from aquifer discharge can be computed. Computed flows at individual cells may have significant error, but the collective flow over the 11 cells adequately represents the gain to the river. Similar caution must be used when identifying changes in water table elevations. Computed water table changes are correct when taken over a range of nodes, but changes at a particular point should not be used. Simulation of various changes in water use practices in the study area were performed individually to estimate their impacts on water levels and aquifer discharges. The results for the scenarios analyzed in this study indicate the general magnitude of impacts of water use practices and are not additive or predictions of future conditions.

REVIEW OF TRUST/NON-TRUST GROUND WATER LINE

The trust/non-trust ground water line was established by IDWR hydrogeologists in 1986 as a result of the negotiated 1984 Swan Falls Agreement between Idaho Power Company and the State of Idaho. This agreement defined conditions under which Idaho Power Company's rights at Swan Falls receive natural flow from above and below the Snake River at Milner. The trust/non-trust ground water areas are shown in Figure 2. The two areas are separated by an administrative boundary which runs along an apparent ground water ridge that divides the direction of ground water movement to the Snake River above and below Milner. As shown in Figure 3, this line runs in a northeast to southwest direction across the ESPA creating the two areas. The upper section represents the area where ground water is considered tributary below Milner (trust water); the bottom section represents the area where ground water is considered tributary above Milner (non-trust water).

The trust/non-trust line was originally established based on over 400 water level measurements taken in 1980 by the USGS (Garabedian, 1992) for the Regional Aquifer System Analysis Study (RASA) and, in local areas, on other pre-1986 data. The line was first drawn perpendicular to ground water contours, but for administrative purposes was moved to follow public land survey section boundaries. The Settlement Agreement called for a review of the line using more recent data since conditions had possibly changed from 1980 to 1993. A review of the trust/non-trust line across the ESPA was included by the technical committee as a study element.

Water level data in a zone approximately 25 miles wide along the original line were plotted using 1993 USGS records. Two contour maps were drawn, one for the spring of 1993 using 66 observation wells (Figure 3), and one for the fall of 1993 using 41 wells, and the administrative trust/non-line was plotted on each. These two maps show that the 1993 contours remain relatively perpendicular to the line in both spring and fall. Although there were some minor inconsistencies, likely due to differences in data densities, neither of the two maps suggest a change from the original line is justified.

Figure 2. Trust & Non Trust Groundwater Areas

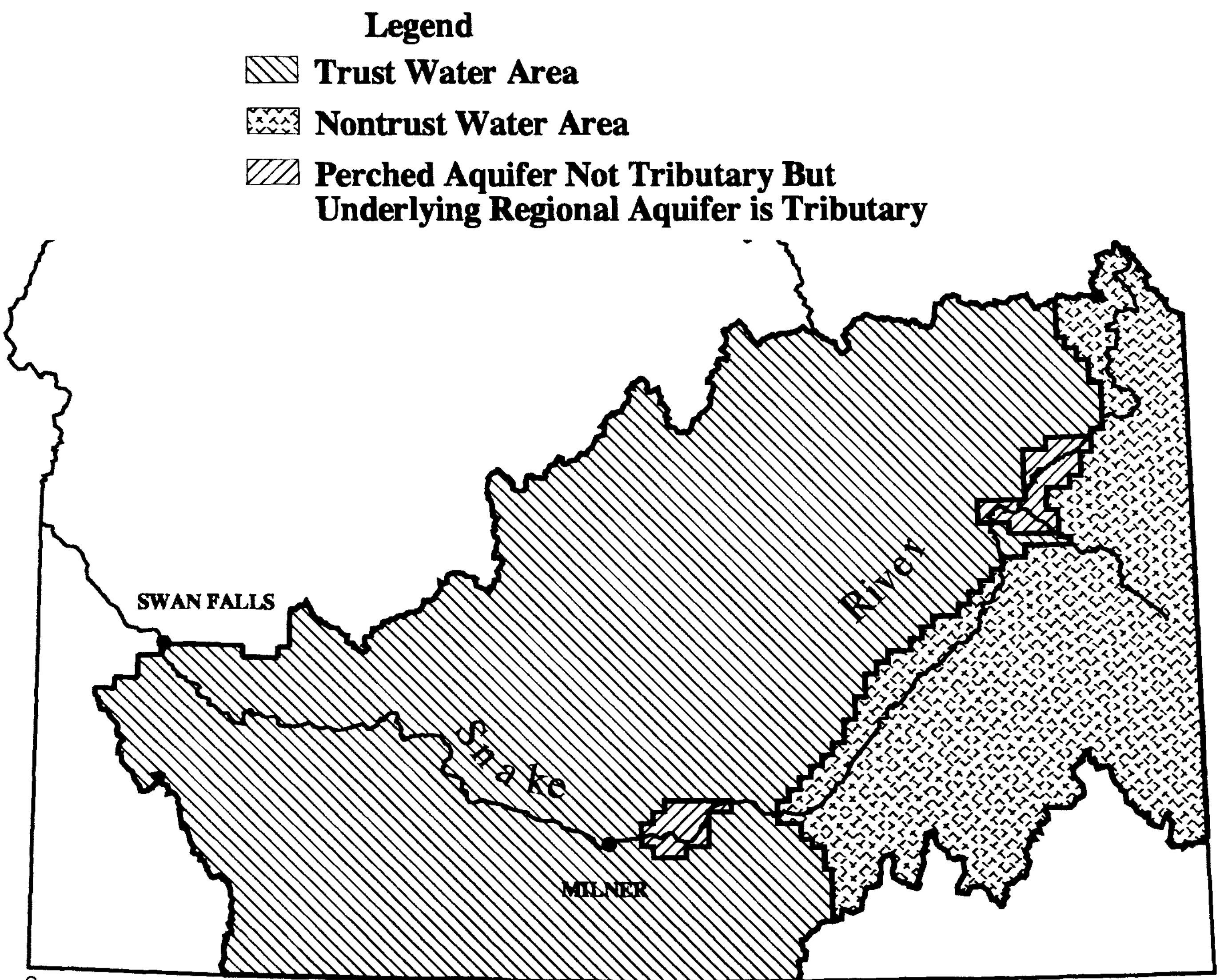

Figure 3. Trust/ Non-Trust Line Overlying ESPA
and Spring 1993 Ground Water Elevations